Fermi-LAT study of two gamma-ray binaries, HESS J0632+057 and AGL J2241+4454

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GeV gamma-ray emission from two gamma-ray binary candidates, HESS J0632+057 and AGL J2241+4454, which were recently reported by H.E.S.S. and AGILE, respectively, have been searched for using the Fermi-LAT archival dataset. Spatial and temporal distribution of gamma-ray events are studied, but there was no evidence for GeV gamma-ray signal from either sources.

1. INTRODUCTION

X-ray binaries are rather common Galactic X-ray objects and about 300 sources are catalogued. Recently several objects have been reported to emit gamma-rays of GeV and/or TeV energies which are modulated in their orbital periods, and a new category of gamma-ray binaries is emerging (Mirabel [2012]), but their emission mechanism is not understood well. It is clear that we need more observations and samples for the detailed study of their nature.

In this study, gamma-ray emissions from HESS J0632+057, for which 321-day period has been found recently, and AGL J2241+4454, which could be identified with a Be star binary with 60-day period, have been searched for using the Fermi-LAT data in the GeV energy range.

2. HESS J0632+057

This object was found as a TeV point source by H.E.S.S. in the Monoceros SNR/Rosetta Nebula region (Aharonian et al. [2009]). It coincides with a massive star MWC148/XMMU J063259.3+054801 ($d \sim 1.5$ kpc) which is variable on hour timescales, and is suspected to be a binary system (Hinton et al. [2009]). Then, 321 ± 5 day period was found in the XMMU source (Bongiorno et al. [2011]). TeV follow-up observations for 6 years have revealed that gamma-ray fluxes are modulated at this period (Maier et al. [2011], Aleksic et al. [2012]) (see Fig.1). However, this object is not listed in the Second Fermi-LAT catalog (Nolan et al. [2012]).

We analyzed LAT gamma-ray data above 200 MeV for 3.5 years using the Fermi Science Tools (version v9r27p1) with `P7SOURCE_V6` response function. The resulting skymap is shown in Fig. 2. The likelihood analysis yielded no significant signal, and we found

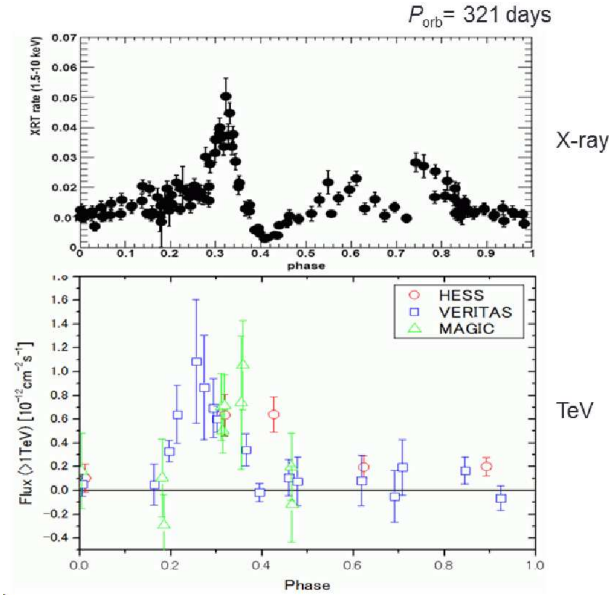

Figure 1: Light curves of HESS J0632+057 (Maier et al. [2011], Aleksic et al. [2012]).

no evidence for gamma-ray emission. We obtained an upper limit of 1.0×10^{-8}cm^{-2}s^{-1} (90% C.L.) for 1-year data (3.5 year-data is under analysis). The spectral energy distribution is shown in Fig. 3 with radio and X-ray data (Skilton et al. [2009]) where the GeV limit is very close to model expectations assuming inverse Compton emission (solid: $E^{-2.0}$ electron injection with $E_{\rm min} = 1$ GeV, dashed: $E^{-1.9}$ / 1 GeV, dotted: E^{-2} / 2 GeV).

Orbital modulation of GeV gamma-ray emission has been investigated assuming the 321 day period. We could not find any significant phase bins, and Fig. 4 shows the upper-limit light curve.

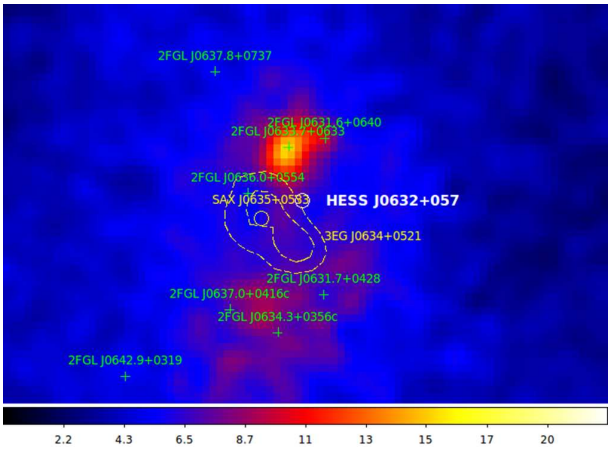

Figure 2: Gamma-ray countmap above 200 MeV around HESS J0632+057.

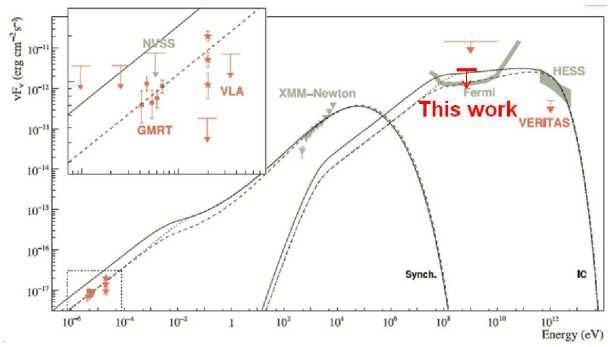

Figure 3: Multiwavelength spectrum of HESS J0632+057 (Hinton et al. [2009]) with our upper limit. See text for model curves,

3. AGL J2241+4454

AGILE reported the discovery of this object for a short period (2010-07-25/26) with a flux of 1.5×10^{-6}cm^{-2}s^{-1} above 100 MeV (Lucarelli et al. [2010]). However, Fermi-LAT observations could not confirm this detection and set an upper limit of 1.0×10^{-7}cm^{-2}s^{-1} (95% C.L.) above 100 MeV (FermiSky blog [2012]). It could be identified as a Be star HD 215227 (MWC 656) showing an orbital period of 60.37 ± 0.04 days (Williams et al. [2010]).

We analyzed LAT gamma-ray data above 100 MeV using the Fermi Science Tools as in the previous section. The resulting skymap is shown in Fig.5 (2010-07-25/26) and Fig. 6 (3.5 years). We found no evidence for gamma-ray emission and obtained upper limits of 7.2×10^{-8}cm^{-2}s^{-1} and 9.4×10^{-10}cm^{-2}s^{-1} (90% C.L.) for the two-day data and 3.5-year data, respectively.

Orbital modulation of GeV gamma-ray emission has been investigated assuming the 60.37 day period. We could not find any significant phase bins, and Fig. 7 shows the upper-limit light curve.

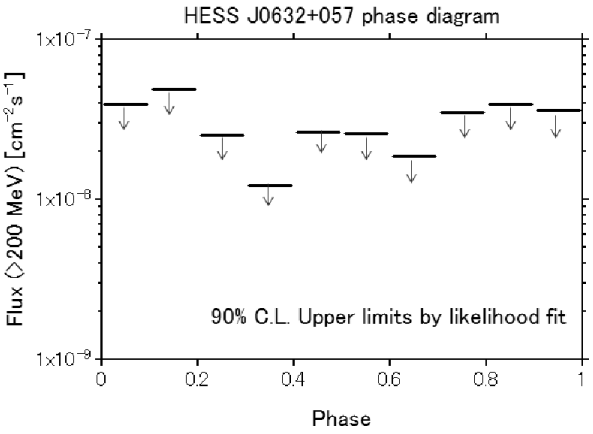

Figure 4: Orbital-phase-resolved upper limits on HESS J0632+057.

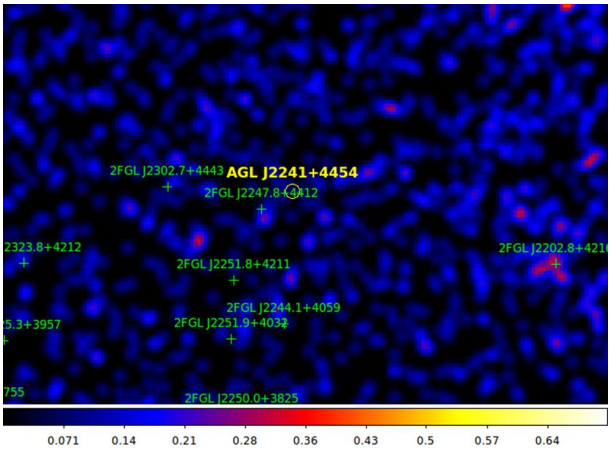

Figure 5: Gamma-ray countmap above 100 MeV around AGL J2241+4454 (2010-07-25/26).

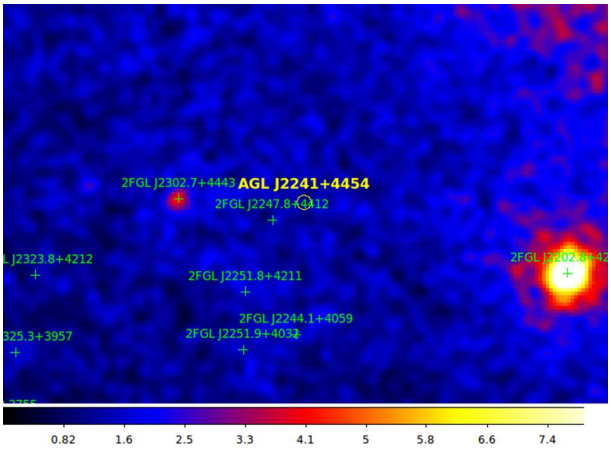

Figure 6: Gamma-ray countmap above 100 MeV around AGL J2241+4454 (3.5 years).

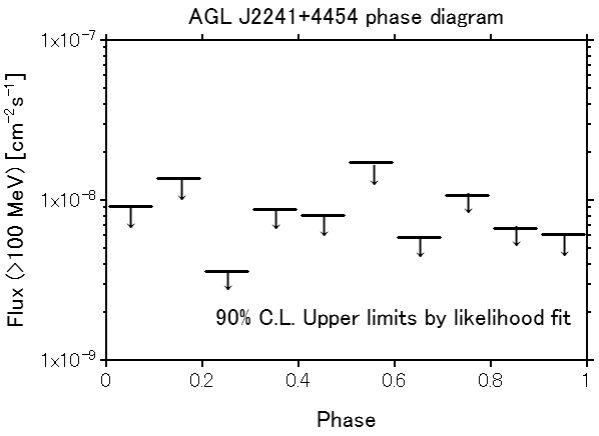

Figure 7: Orbital-phase-resolved upper limits on AGL J2241+4454.

4. SUMMARY

We have searched for GeV gamma-ray emission from HESS J0632+057 and AGL J2241+4454 using the Fermi-LAT data. No significant signal was found from either objects and long-term and orbital-phase-resolved upper limits have been set on gamma-ray fluxes which set restriction on their high-energy activities.

Acknowledgments

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